Nanophase of water in nano-diamond and fullerene gels and dispersions

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Nanophase of water (NPhW) has been discovered in gels prepared from stable water dispersions of nano-diamond (d ~ 5 nm) and fullerene C_{60} clusters (d ~ 68 nm). Two endo-effects have been observed in DSC (Differential Scanning Calorimetry) traces of these gels. The sharp peak at T= 273K corresponded to the melting of bulk water. The broad peak at lower temperature was attributed to the melting of NPhW. The depression of melting temperature was explained in terms of Gibbs-Kelvin equation. Two exo – effects of freezing have been detected while scanning down of the same samples. In samples prepared with D_2O instead of H_2O the melting temperatures were shifted up by 3-4 degrees. Mass of NPhW per mass of carbon particle, melting temperature and enthalpy of NPhW have been derived from the DSC data.

The characteristic size of NPhW in nano-diamond and fullerene gels correlated with the size of corresponding carbon nanoparticles. Mass of NPhW depended on pH of water. NPhW disappeared completely at pH~1. Other liquids e.g. cyclohexane, DMSO and etc. did not form nanophases with the same carbon materials. Melting (freezing) of NPhW has not been observed in gels prepared from water dispersions of shungite and graphite. It could be assumed that water specifically interacts with nano-diamonds and C_{60} clusters by adhering to their surfaces. Based on the experimental results obtained one may propose a preliminary model of a stable carbon nanoparticle present in aqueous gel and dispersion. The model consists of a nonporous carbon nucleus surrounded by a spherical shell of adsorbed water, NPhW. For the system with nano-diamonds the parameters of the model were calculated from the DSC experimental data. These results demonstrate that DSC could be a new versatile tool for quantitative study of the interaction of carbon nanoparticles with different solvents and for investigation of the factors governing the stability of carbon nanoparticles in liquid dispersions. The DSC data were discussed along with the results of other experimental techniques (DLS, SANS, LDE and etc.) reported in the literature for the same systems of carbon nanoparticles.

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